

CLAIMS

What is claimed is:

1. A computer-implemented method for providing automatic, personalized information services to a user u , the method comprising:
 - a) transparently monitoring user interactions with data while the user is engaged in normal use of a computer;
 - b) updating user-specific data files, wherein the user-specific data files comprise the monitored user interactions with the data and a set of documents associated with the user;
 - c) estimating parameters of a learning machine, wherein the parameters define a User Model specific to the user and wherein the parameters are estimated in part from the user-specific data files;
 - d) analyzing a document d to identify properties of the document;
 - e) estimating a probability $P(u|d)$ that the document d is of interest to the user u , wherein the probability $P(u|d)$ is estimated by applying the identified properties of the document to the learning machine having the parameters defined by the User Model; and
 - f) using the estimated probability to provide automatic, personalized information services to the user.
2. The method of claim 1 wherein the user-specific data files include documents of interest to the user u and documents that are not of interest to the user u , and wherein estimating the parameters comprises distinct treatment of the documents of interest and the documents that are not of interest.
3. The method of claim 1 wherein analyzing the document d provides for the analysis of documents having multiple distinct media types.
4. The method of claim 1 wherein transparently monitoring user interactions with data comprises monitoring multiple distinct modes of user interaction with network data.
5. The method of claim 4 wherein the multiple distinct modes of user interaction comprise a mode selected from the group consisting of a network

3 searching mode, a network navigation mode, a network browsing mode, an
 4 email reading mode, an email writing mode, a document writing mode, a
 5 viewing "pushed" information mode, a finding expert advice mode, and a
 6 product purchasing mode.

1 6. The method of claim 1 further comprising crawling network documents, wherein
 2 the crawling comprises parsing crawled documents for links, calculating probable
 3 user interest in the parsed links using the learning machine, and preferentially
 4 following links likely to be of interest to the user.

1 7. The method of claim 1 wherein the identified properties of the document d
 2 comprise a user u -independent property selected from the group consisting of:
 3 a) a probability $P(t, d)$ that the document d is of interest to users interested in a
 4 topic t ;
 5 b) a topic classifier discrete probability distribution $P(t|d)$;
 6 c) a product model discrete probability distribution $P(p|d)$;
 7 d) product feature values extracted from the document d ;
 8 e) an author of the document d ;
 9 f) an age of the document d ;
 10 g) a list of documents linked to the document d ;
 11 h) a language of the document d ;
 12 i) a number of users who have accessed the document d ;
 13 j) a number of users who have saved the document d in a favorite document
 14 list; and
 15 k) a list of users previously interested in the document d .

1 8. The method of claim 1 wherein the parameters of the learning machine define a
 2 user u -dependent function selected from the group consisting of:
 3 a) a user topic probability distribution $P(t|u)$ representing interests of the user u
 4 in various topics t ;
 5 b) a user product probability distribution $P(p|u)$ representing interests of the
 6 user u in various products p ;
 7 c) a user product feature probability distribution $P(f|u, p)$ representing interests
 8 of the user u in various features f of each of the various products p ;

- d) a web site probability distribution $P(s|u)$ representing interests of the user u in various web sites s ;
- e) a cluster probability distribution $P(c(u)|u)$ representing similarity of the user u to users in various clusters $c(u)$;
- f) a phrase model probability distribution $P(w|u)$ representing interests of the user u in various phrases w ;
- g) an information theory based measure $I(I_w; I_u)$ representing mutual information between various phrases w and the user u ;
- h) an information theory based measure $I(I_t; I_u)$ representing mutual information between various topics t and the user u ;
- i) an information theory based measure $I(I_s; I_u)$ representing mutual information between various web sites s and the user u ;
- j) an information theory based measure $I(I_p; I_u)$ representing mutual information between various products p and the user u ; and
- k) an information theory based measure $I(I_f; I_u)$ representing mutual information between various features f of each of the various products p and the user u .

9. The method of claim 1 wherein the parameters of the learning machine define:
- a) a user product probability distribution $P(p|u)$ representing interests of the user u in various products p ; and
 - b) a user product feature probability distribution $P(f|u,p)$ representing interests of the user u in various features f of each of the various products p ;
- and wherein the method further comprises estimating a probability $P(u|d, \text{product described}=p)$ that a document d that describes a product p is of interest to the user u , wherein the probability is estimated in part from the user product probability distribution and the user product feature probability distribution.

10. The method of claim 9 further comprising recommending products to the user based on the probability $P(u|d, \text{product described}=p)$.

11. The method of claim 1 further comprising estimating a posterior probability $P(u|d,q)$ that the document d is of interest to the user u , given a query q submitted by the user.

12. The method of claim 11 wherein estimating the posterior probability comprises estimating a probability $P(q|d,u)$ that the query q is expressed by the user u with an information need in the document d .

13. The method of claim 1 further comprising applying the identified properties of the document d to a learning machine having product parameters characterizing a product p to estimate a probability $P(p|d)$ that the document d refers to the product p .

14. The method of claim 13 further comprising updating the product parameters based on the identified properties of the document d and the estimated probability $P(p|d)$.

15. The method of claim 13 further comprising initializing the product parameters based on a set of documents associated with the product p .

16. The method of claim 1 further comprising clustering multiple users into clusters of similar users, wherein the clustering comprises calculating distances between User Models, and selecting similar users based on the calculated distances between User Models.

17. The method of claim 1 further comprising calculating relative entropy values between User Models of multiple users, and clustering together users based on the calculated relative entropy values.

18. The method of claim 1 wherein the parameters defining the User Model comprise calculated distances between the User Model and User Models of users similar to the user.

19. The method of claim 1 further comprising selecting in a group of users an expert user in an area of expertise, wherein selecting the expert user comprises finding an expert User Model among User Models of the group of users, such that the expert User Model indicates a strong interest of the expert user in a document associated with the area of expertise.

- 1 20. The method of claim 1 further comprising parsing the document d for hyperlinks,
2 and separately estimating for each of the hyperlinks a probability that the
3 hyperlink is of interest to the user u .
- 1 21. The method of claim 1 further comprising sending to a third party web server user
2 interest information derived from the User Model, whereby the third party web
3 server may customize its interaction with the user.
- 1 22. The method of claim 1 wherein the monitored user interactions include a sequence
2 of interaction times.
- 1 23. The method of claim 1 further comprising initializing the User Model using
2 information selected from the group consisting of a set of documents provided by
3 the user, a web browser history file associated with the user, a web browser
4 bookmarks file associated with the user, ratings by the user of a set of documents,
5 and previous product purchases made by the user.
- 1 24. The method of claim 1 further comprising modifying the User Model based on
2 User Model modification requests provided by the user.
- 1 25. The method of claim 1 further comprising providing to the user a score for a
2 document identified by the user, wherein the score is derived from the estimated
3 probability.
- 1 26. The method of claim 1 further comprising providing to the user a 3D map of a
2 hyper linked document collection, wherein the 3D map indicates a user interest in
3 each document.
- 1 27. The method of claim 1 further comprising temporarily using a User Model that is
2 built from a set of predetermined parameters of a profile selected by the user.
- 1 28. The method of claim 1 further comprising initializing the User Model by selecting
2 a set of predetermined parameters of a prototype user selected by the user.

- 1 29. The method of claim 28 further comprising updating the predetermined
2 parameters of the prototype user based on actions of users similar to the
3 prototype user.
- 1 30. The method of claim 1 further comprising identifying a set of users interested in
2 the document d .
- 1 31. The method of claim 30 further comprising calculating a range of interests in
2 the document d for the identified set of users.
- 1 32. A program storage device accessible by a central computer, tangibly embodying a
2 program of instructions executable by the central computer to perform method steps for
3 providing automatic, personalized information services to a user u , the method steps
4 comprising:
5 a) transparently monitoring user interactions with data while the user is engaged in
6 normal use of a client computer in communication with the central computer;
7 b) updating user-specific data files, wherein the user-specific data files comprise the
8 monitored user interactions with the data and a set of documents associated with
9 the user;
10 c) estimating parameters of a learning machine, wherein the parameters define a User
11 Model specific to the user and wherein the parameters are estimated in part from
12 the user-specific data files;
13 d) analyzing a document d to identify properties of the document;
14 e) estimating a probability $P(u|d)$ that the document d is of interest to the user u ,
15 wherein the probability $P(u|d)$ is estimated by applying the identified properties of
16 the document to the learning machine having the parameters defined by the User
17 Model; and
18 f) using the estimated probability to provide automatic, personalized information
19 services to the user.
- 1 33. The program storage device of claim 32 wherein the user-specific data files
2 include documents of interest to the user u and documents that are not of interest

to the user u , and wherein estimating the parameters comprises distinct treatment of the documents of interest and the documents that are not of interest.

34. The program storage device of claim 32 wherein analyzing the document d provides for the analysis of documents having multiple distinct media types.

35. The program storage device of claim 32 wherein transparently monitoring user interactions with data comprises monitoring multiple distinct modes of user interaction with network data.

36. The program storage device of claim 35 wherein the multiple distinct modes of user interaction comprise a mode selected from the group consisting of a network searching mode, a network navigation mode, a network browsing mode, an email reading mode, an email writing mode, a document writing mode, a viewing "pushed" information mode, a finding expert advice mode, and a product purchasing mode.

37. The program storage device of claim 32 wherein the method steps further comprise crawling network documents, wherein the crawling comprises parsing crawled documents for links, calculating probable user interest in the parsed links using the learning machine, and preferentially following links likely to be of interest to the user.

38. The program storage device of claim 32 wherein the identified properties of the document d comprise a user u -independent property selected from the group consisting of:

- a) a probability $P(t, d)$ that the document d is of interest to users interested in a topic t ;
- b) a topic classifier discrete probability distribution $P(t|d)$;
- c) a product model discrete probability distribution $P(p|d)$;
- d) product feature values extracted from the document d ;
- e) an author of the document d ;
- f) an age of the document d ;
- g) a list of documents linked to the document d ;

- 12 h) a language of the document d ;
- 13 i) a number of users who have accessed the document d ;
- 14 j) a number of users who have saved the document d in a favorite document
- 15 list; and
- 16 k) a list of users previously interested in the document d .

- 1 39. The program storage device of claim 32 wherein the parameters of the learning
 2 machine define a user u -dependent function selected from the group consisting of:
- 3 a) a user topic probability distribution $P(t|u)$ representing interests of the user u
 - 4 in various topics t ;
 - 5 b) a user product probability distribution $P(p|u)$ representing interests of the
 - 6 user u in various products p ;
 - 7 c) a user product feature probability distribution $P(f|u, p)$ representing interests
 - 8 of the user u in various features f of each of the various products p ;
 - 9 d) a web site probability distribution $P(s|u)$ representing interests of the user u
 - 10 in various web sites s ;
 - 11 e) a cluster probability distribution $P(c(u)|u)$ representing similarity of the user
 - 12 u to users in various clusters $c(u)$;
 - 13 f) a phrase model probability distribution $P(w|u)$ representing interests of the
 - 14 user u in various phrases w ;
 - 15 g) an information theory based measure $I(I_w; I_u)$ representing mutual
 - 16 information between various phrases w and the user u ;
 - 17 h) an information theory based measure $I(I_t; I_u)$ representing mutual information
 - 18 between various topics t and the user u ;
 - 19 i) an information theory based measure $I(I_s; I_u)$ representing mutual
 - 20 information between various web sites s and the user u ;
 - 21 j) an information theory based measure $I(I_p; I_u)$ representing mutual
 - 22 information between various products p and the user u ; and
 - 23 k) an information theory based measure $I(I_f; I_u)$ representing mutual information
 - 24 between various features f of each of the various products p and the user u .

- 1 40. The program storage device of claim 32 wherein the parameters of the learning
 2 machine define:

- 3 a) a user product probability distribution $P(p|u)$ representing interests of the
 4 user u in various products p ; and
 5 b) a user product feature probability distribution $P(f|u,p)$ representing interests
 6 of the user u in various features f of each of the various products p ;
 7 and wherein the method steps further comprise estimating a probability $P(u|d,$
 8 product described= $p)$ that a document d that describes a product p is of interest to
 9 the user u , wherein the probability is estimated in part the user product probability
 10 distribution and the user product feature probability distribution.

1 41. The program storage device of claim 40 wherein the method steps further
 2 comprise recommending products to the user based on the probability $P(u|d,$
 3 product described= $p)$.

1 42. The program storage device of claim 32 wherein the method steps further
 2 comprise estimating a posterior probability $P(u|d,q)$ that the document d is of
 3 interest to the user u , given a query q submitted by the user.

1 43. The program storage device of claim 42 wherein estimating the posterior
 2 probability comprises estimating a probability $P(q|d,u)$ that the query q is
 3 expressed by the user u with an information need in the document d .

1 44. The program storage device of claim 32 wherein the method steps further
 2 comprise applying the identified properties of the document d to a learning
 3 machine having product parameters characterizing a product p to estimate a
 4 probability $P(p|d)$ that the document d refers to the product p .

1 45. The program storage device of claim 44 wherein the method steps further
 2 comprise updating the product parameters based on the identified properties
 3 of the document d and the estimated probability $P(p|d)$.

1 46. The program storage device of claim 44 wherein the method steps further
 2 comprise initializing the product parameters based on a set of documents
 3 associated with the product p .

- 1 47. The program storage device of claim 32 wherein the method steps further
2 comprise clustering multiple users into clusters of similar users, wherein the
3 clustering comprises calculating distances between User Models, and selecting
4 similar users based on the calculated distances between User Models.
- 1 48. The program storage device of claim 32 wherein the method steps further
2 comprise calculating relative entropy values between User Models of multiple
3 users, and clustering together users based on the calculated relative entropy values.
- 1 49. The program storage device of claim 32 wherein the parameters defining the User
2 Model comprise calculated distances between the User Model and User Models of
3 users similar to the user.
- 1 50. The program storage device of claim 32 wherein the method steps further
2 comprise selecting in a group of users an expert user in an area of expertise,
3 wherein selecting the expert user comprises finding an expert User Model among
4 User Models of the group of users, such that the expert User Model indicates a
5 strong interest of the expert user in a document associated with the area of
6 expertise.
- 1 51. The program storage device of claim 32 wherein the method steps further
2 comprise parsing the document d for hyperlinks, and separately estimating for
3 each of the hyperlinks a probability that the hyperlink is of interest to the user u .
- 1 52. The program storage device of claim 32 wherein the method steps further
2 comprise sending to a third party web server user interest information derived
3 from the User Model, whereby the third party web server may customize its
4 interaction with the user.
- 1 53. The program storage device of claim 32 wherein the monitored user interactions
2 include a sequence of interaction times.
- 1 54. The program storage device of claim 32 wherein the method steps further
2 comprise initializing the User Model using information selected from the group

3 consisting of a set of documents provided by the user, a web browser history file
 4 associated with the user, a web browser bookmarks file associated with the user,
 5 ratings by the user of a set of documents, and previous product purchases made by
 6 the user.

1 55. The program storage device of claim 32 wherein the method steps further
 2 comprise modifying the User Model based on User Model modification requests
 3 provided by the user.

1 56. The program storage device of claim 32 wherein the method steps further
 2 comprise providing to the user a score for a document identified by the user,
 3 wherein the score is derived from the estimated probability.

1 57. The program storage device of claim 32 wherein the method steps further
 2 comprise providing to the user a 3D map of a hyper linked document collection,
 3 wherein the 3D map indicates a user interest in each document.

1 58. The program storage device of claim 32 wherein the method steps further
 2 comprise temporarily using a User Model that is built from a set of predetermined
 3 parameters of a profile selected by the user.

1 59. The program storage device of claim 32 wherein the method steps further
 2 comprise initializing the User Model by selecting a set of predetermined
 3 parameters of a prototype user selected by the user.

1 60. The program storage device of claim 59 wherein the method steps further
 2 comprise updating the predetermined parameters of the prototype user based
 3 on actions of users similar to the prototype user.

1 61. The program storage device of claim 32 wherein the method steps further
 2 comprise identifying a set of users interested in the document *d*.

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62. The program storage device of claim 61 wherein the method steps further comprise calculating a range of interests in the document d for the identified set of users.